COSTGOLD RESEARCH LTD.

Cambridge
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C-ROM Bios Ver 1.2

Users Manual

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1.   Introduction

This is the user manual for the Costgold Research Ltd CA856
and CA866 16 bit 80-BUS processor cards when fitted with the C-
ROM Bios firmware. The C-ROM Bios is contained in a 2764 type of
EPROM.

The C-ROM Bios gives a Costgold Research CA856 or CA866
card the   ability to load and run a wide range of commercially
available   operating   systems   for Intel   8088/8086 based
computers.   This is done by providing a terminal emulation
program for an IBM PC or equivalent computer, together with a
set of ROM based programs for general I/O including disc,
printer, serial port and real time clock.   These calls use
the now industry standard interface of the IBM PC.

The   installation of this card in an   existing 80-BUS
computer system will enable it to run the Microsoft MS-DOS
operating system, and a wide range of software available for this
operating system.

It   should be noted that if an application program does not
use the ROM Bios interface, then it   may   not   function
correctly. Generally, however, a wide range of software is
available for MS-DOS computers in a "generic" form (ie not
specifically IBM), with terminal configuration programs.

This document does not attempt to describe the operating
system features and facilities in any way, and before the system
is used it is vital that the user should carefully study all
the operating system guides and then read this document to
ascertain the differences between the normal operation of the
system and its implementation on an 80-BUS computer.

The recommended minimum configuration for operation is
as follows:

        a. Costgold Research CA856 or CA866 card.

        b. At least 128k of RAM.

        c. Gemini IVC/SVC display card.

        d. GM852/GM827 Keyboard or similar.

        e. Gemini Floppy Disc Controller Card (with SCSI
        interface if hard disc is to be used).

        f. At least one and preferably two 40 or 80 track drives.
        These may be mixed.

        g. A hard disc is recommended for all   MS-DOS
        applications.

The C-ROM Bios will support a wide range of PC compatible operating systems (excluding Digital Research CPM/86 for the PC and CCPM/86 for the PC). A special version of CP/M-86 for use with the CA856 or CA866 is available from Gemini Computer Systems Limited.

The ROM bios will allow the operating system to be booted and run. using 40 track single or double sided systems discs. An 80 track to 40 track emulation is provided. Using the PR Utilities pack from Costgold Research the following additional features are provided.

        a. Emulation of PC function keys.

        b. Use of CA856/866 on-board clock to provide system date and time.

        c. Formatting of 80 track single and double sided discs in an MS-DOS compatible format.

        d. Full use of an 80 track drive via a "Device Driver".

        e. Control of the memory control for screen width.

        f. Selection of 3 millisecond/6 millisecond stepping.

        g. Selection of single stepping/double stepping.

2.   Installation

The CA856/866 may be installed in a wide variety of systems. It is important that the following description of modes of operation is carefully read, and all the implications for the system being employed are fully understood.

2.1 Modes of Operation

This describes the different operational modes which may be used with the CA856 when it is installed in a Gemini system. There are three different modes.

            Mode   A.   - Dual Processor Mode (Slave CA 856)

            Mode   B.   - CA 856 Master Mode

            Mode   C.   - CA 856 Standalone Mode

These modes of operation must be selected at installation, and require the fitting of a number of link options to select the operational modes.

The modes of operation rely on the presence on the 80-BUS of two control lines - BUSREQ, which is an active low signal which may be used to signal to the current bus master that it should release the bus and go into an "idle" state, and BAI (which is an abbreviation for Bus Acknowledge In) which is a signal from the bus master to the requesting bus master that the bus is available and that it may start using the bus for its own purposes. These two signals are "active low", in that they are a low voltage output when they are actually in their active state. For further information on these signals see the GM811, GM813 Hardware Reference Manual.

2.2 Selection of Modes

The modes are controlled by two links. Both these links are placed between A56 and A57 which is the Real Time Clock chip in the top left hand corner.

Link "g" is used to select modes.

OPEN (as shipped) selects Modes B or C.

CLOSED (ie shorted to ground) selects Mode A.

Link "1" is only used in Mode A. Until it has been shorted to ground the 8088 will not request the 80-BUS. See also link "1" in the description of Mode A below.

Mode A. - Dual Processor Mode

It is difficult to arrange that the Z-80 processor may easily switch in and out for the following reasons:

a. The CA 856 has its own internal RAM, and when executing a program from this RAM the 80-BUS is not refreshed. This means that very rapidly the contents of the 80-BUS dynamic ram become corrupted, and so it is necessary to re-boot CP/M-80.

b. The Z-80 processor cards do not have multi-bus master operation designed in, and so it is not possible to arrange to swap from one card to another.

c. The Reset control circuitry of the Z-80 processor cards does not allow them to be reset whilst the Z80 is disabled by the 8088 processor of the CA 856.

To allow easy use of the Z80 processor the following procedure must be adopted:

Set Link a on the CA 856 to select Mode A. This requires the link to be fitted.

Link i is then used to flag the processor that it may commence execution and take control of the bus from the Z80 card. To signal this, the link input must be shorted to ground. It is suggested that the 'Aux' output of the GM 811/GM 813 is used for this. This is next to the 5 pin DIN socket and the pin nearest the edge of the board should be connected to the hole immediately next to the resistor R6 on the GM 836/866.

Link i, the link that controls the state of the Busreq line at power up must be connected as shown:

```
        Gi
                        T1
    X ========= X              ====
    .           .              ====)
                               ====) Edge connector
    .           .              ====)
    X ========= X              ====


        -||- C14
```

Please note that the default position of the link is vertical, and it is necessary to break the tracks on the reverse side of the card from the components.

At power up or reset the Z80 will run, and attempt to boot off the disc.   If the boot fails it will enter RPM if this is available and this will allow the user to enter the following commands to select the CA836:

    <rpm_prompt>* cbc 0

This will enable the /OUT1 output of the 8230, which will in turn activate the AUX output drive transistor.   If this has been connected to the "i" input link of the CA 836 it will then signal the 8086 to request the bus and continue its processing.

    It is also possible to write a very simple program which would allow the Z-80 to switch itself out - see Appendix A.

Mode B.   - CA856 Master Mode

In this mode the CA 856 will gain control of the bus automatically at reset.   The Z-80 processor will never run. However, its IO may be accessed and so the serial and parallel port may be used.

The Z-80 also provides the system clock.

The following link positions should be set.

    Link "i" (See Mode A for location)

```
                    Q1
                                    ...
            X  .   .   . A            ====
            ||            ||          ====)
            ||            ||          ====) Edge connector
            ||            ||          ====)
            X  .   .   . X            ====


            -||- C14
```

    Link "g" and "i" are ignored in this mode.

    Link "d" and "j" must be open (this is the normal shipping mode for these links).

Mode C.   - CA856 Standalone

In this mode the CA856 may be run as the sole processor in
the system. To allow this, the 8088 card must provide the system
clock and also the /BAI signal in must be made active (ie low).

Link positions are thus:

Link "I" (See Mode A for location)

```
                    Q1
                                    . .
        X  .  .  .  X                    ====
        | |            | |               ====)
        | |            | |               ====) Edge connector
        | |            | |               ====)
        X  .  .  .  X                    ====


                  -||- C14
```

Link "g" and "i" are ignored in this mode.

Link "J" must be connected. This will connect /BAI to
link "m".

Link "m" must be connected. This will ground /BAI.

Link "J" must be connected. This will connect the on-
board 4MHz clock to the 80-BUS. This is needed for the
FDCC and the display cards.

3.   System Operation

After selecting the appropriate operating mode, and carefully installing the card in the system, operation may be commenced. It is important to note that if the card is being used in either Mode A or Mode B it must be placed so that its BUSREQ line will automatically hold the Z-80 processor at power up.

When power is applied to the system, the display should blank, and the display card initialisation message should appear:

"IVC 2.0 etc"

(The exact message depends upon whether the system has an IVC or SVC and which version of the display card firmware is fitted.)

If the system is in Mode A, then the normal GM813 operations will then ensue. This will continue until the Mode A change link (link 1 on the CA856/866 is shorted to ground). The CA856/866 will then exert a BUSREQ and take control of the system. This will then be followed by the normal CA856/866 sign-on message.

In the case of Mode B and Mode C the CA856/866 will immediately take control of the system after power-up or when the reset button is pressed.

The processor then performs a system initialisation and a complete memory test. The memory test enables it to determine the amount of system memory available. The C-ROM Bios itself requires some of the system memory for its operation, and this is reserved after the maximum size of memory has been found.

At least 64kbytes of RAM must be found in the system. However the maximum amount of RAM in the system may be much more than this - for use with MS-DOS a minimum suggested amount of RAM is 192k bytes.

The standard CA856 is provided with 256k bytes of RAM. Where the CA866 is employed it is possible to a mix of dynamic and static RAM. The RAM check program at power up requires these to be in 8k contiguous increments if all the memory is to be available to the operating system.

3.1 System Boot Up Procedure

Upon the successful completion of the memory test the C-ROM Bios will look for an operating system. This may be either on floppy or hard disc. If a hard disc is provided. To distinguish between the Version 3.1 and earlier Costgold Research Limited CP/M-86. and a PC compatible operating system the following procedure is adopted:

1. The A: drive is selected, and an attempt is made to read the first track of the first side starting at sector 0. If this succeeds. then the second track of the first side will be loaded in to memory, and if the code bytes at the beginning of the disc correspond to the Costgold Research CP/M-86 operating system then execution will commence at 1000:0.

2. If step 1. fails, then an attempt will be made to read sector 1 of the first track of the first side into memory. If this is successful, then this will be executed. This would be the boot sector of the MS-DOS or PC-DOS operating system if the disc was a systems disc for one of those operating systems.

3. If step 2. fails, then the hard disc will be accessed. Firstly, the first sector of the hard disc is read into memory. This contains a special control byte which establishes what kind of hard disc system is incorporated. If the hard disc has not previously been used or has just been "hard formatted", then this control byte will not be in a valid range. In this case, the user is prompted to select the appropriate Winchester type supported.

BE CAREFUL - This menu is only offered once, and if the wrong type of drive is selected, then it will be necessary to reformat the Winchester entirely.

4. If step 3. fails then an error message is printed, and the user must select an operating system diskette, place this in drive A: and press the reset button.

3.2   Use of C-ROM Bios with PC compatible software

A   standard distribution copy of the operating system will
load correctly but to obtain the full use of the system, the
reader is referred to the section about the special Device
Drivers available from Costgold Research which allow extra
facilities.

An important point is that time/date stamping of files is
not   supported unless the Real Time clock chip driver is
incorporated.

Once the operating system is loaded careful reference should
be made   to the specific operating   system   manual   for
specific variations.

3.3   Use of C-ROM Bios with CP/M-86

A special form of CP/M-86 is available from Costgold Research
for use with the C-ROM Bios.   Updates to existing versions of
CP/M-86 are available from Costgold Research Ltd, either direct or
via the normal distribution channels.

Version 1.1 of the C-ROM Bios does not support CP/M-86 for the IBM
PC or CCP/M-86.

3.4 Operation With Floppy Discs

The standard C-ROM Bios can directly interface with up to two floppy disc drives. These floppy disc drives may be configured by software to have the following features:

o 40 Track

o 80 Track

o 80 Track Double Stepping (ie 40 track emulation)

o Single Sided

o Double Sided

o 6 millisecond step rate

o 6 millisecond step rate

The C-ROM Bios will automatically assume that the system disc controllers are track references to PC compatibility. Special drivers are available to allow the reconfiguration of the media. Any other required format. See the section on Device Drivers and Programmers Utilities.

3.5 Operation with hard discs

The control software for the hard disc is fully compatible and can use up to 60 Megabytes physical capacity. Each disc has up to four partitions, where each partition is controlled by a special table at the end of the hard disc. Each entry in this table is accessed by the operating system DISK. The system is already created for a CP/M version of the CP/M Bios must be obtained to co-exist on the disc at the same time. Please contact your dealer for this and related information. This applies to both CP/M-80 and CP/M-86 operating systems.

For a disc to be used in the system it is necessary for the relevant control information for the hard disc to be contained to initialise the hard disc controller. This is identified to the C-ROM Bios by a byte at the beginning of the control table. After this byte has been set the disc may be used to reformatting the disc. Care should be taken when reformatting the hard disc partitions. Particularly, information on the hard disc is saved before any attempt is made to install the new operating system!

3.6   A Method for Installing a Hard Disc partition

A possible method for installing a hard disc partition on a
system which already has CP/M information on it is now described.
This has one drawback.   After this is complete, the CP/M may only
be booted from floppy disc.   and the MS-DOS will be booted up if
no floppy based operating system is found.

B A C K U P   Y O U R   H A R D   D I S C   F I R S T !

1. Using CPM utilities, create two (or more) CPM directories
where one of these directories is the size you would like
your MS-DOS partition to be. Calculate start and end
cylinder numbers.

2.   Install the CA886. Boot the system. This will prompt you
with a menu to specify the drive type which you should now
do.

3.   Using the MS-DOS utility FDISK, create a partition which
has the same start and end cylinder numbers as in 1.

4.   This will have become the MS-DOS hard disc directory C:.
With the standard MS-DOS operating system this will be up to
10 MB.   Using a Costgold device driver it may be made bigger
than this.

5. Copy back your CPM information to the CPM directories.

6. You will now no longer be able to access the CPM
directory which corresponds to your MS-DOS C: drive. If you
do. you will corrupt your MS-DOS information. It is
suggested that when you create the original CP/M drive for
this purpose you choose a drive identifier you have never
used before to help minimise mistakes.

4. Special Device Drivers and Special Software

An important feature of MS-DOS 2.0 and greater is the ability to generate special systems by loading a special program into memory called a Device Driver. These programs are capable of being incorporated into the operating system, and allow the re-direction of console commands, serial and parallel port accesses etc.

The Device Drivers are placed in a special system configuration file called CONFIG.SYS, which must be present on the same disc as the operating system when the system is being booted. For further information on Device Drivers, refer to MS-DOS technical reference sources and the Programmers Utility Pack Users Manual.

Two device drivers currently available are COSTCLOK.SYS which allows the use of the on-board HM46818 clock to generate system date and time, and CIM80XX.SYS which allows the use of an 80 track diskette in Drive B: (as Drive D:) where XX is DS for double sided drives and SS for single sided drives.

Three other programs are available:

TEAC.COM - configures the system for use with 80 track Teac and other 3ms step rate drives.

PCROTKEY.COM - provides an emulation for IBM PC special function keys.

S80.COM - sets a byte value used by many applications programs at the beginning of memory to a value which indicates that the screen is 80 columns wide.

5. Limitations and incompatibilities

The major problem of compatibility is with the rather unusual screen format of the PC. This uses a memory mapped display with a lot of rather clever features, all of which are particularly difficult to emulate with an IVC or SVC!

C-ROM Bios emulates the PC display by directly accessing the IVC/SVC display memory to enable a reasonable simulation of the monochrome display adapter mode. To establish which programs will run, and which ones will not, it is necessary to experiment!

However many MS-DOS programs are available in a generic MS-DOS form, and these may be run. In this case, it is normally more effective to use their terminal configuration software to directly use the Gemini IVC/SVC control codes.

The IBM PC has the bulk of its BASIC contained within an EPROM which is part of the memory map of the PC. This is obviously not the case with the Costgold Research CA856/856, but many of the "compatibles" have an entirely disc based version of BASIC. These generally work with the following points to be borne in mind.

a. When using the IVC/SVC as a display emulator none of the colour and graphics related commands are supported.

b. The serial comms functions are only partially supported as they bypass the Rom Bios on the PC.

Some utilities (including even some IBM utilities!) don't access control parameters via the software interrupts as they should do, but directly modify control fields in the area of memory used as a "scratch pad" by the PC firmware (400H to 4FFH). The most notable example of this is the screen width control. A utility in the Programmers Utilities pack allows this to be directly set to the required 80. Otherwise Debug may be used. The location of this (WORD) variable is 44AH (absolute address).

6.   Hardware Interfacing Information

This section describes the way in which hardware interface
programs may access the hardware.   There are three major
considerations. the memory map, the IO map and interrupts.

6.1 Memory Map

In the CA856 the memory map is split into two portions - the
RAM map. which is contigous from 0, and the ROM map, which starts
at the last 8k of memory (for the CA856).   The memory map for the
on-board RAM extends to 256kbytes. At power up the initialisation
program performs a complete RAM check starting at 1000:0 until it
finds an error on an 8k boundary. When this happens, it assumes
that the end of memory has been found. An 8k boundary is used
because the same program is used in the CA866 which may have 8k
RAM chips fitted.

To allow the system to be PC-compatible at boot time the
C-ROM Bios "cheats", in that the memory available to the
operating system is less than the actual memory found. It is made
less so that a scratch area is available for special control
fields and an entire "Track Format Buffer" is available for
supporting the "Track Format" function of the Disc Services
Interrupt (INT 13H).   This is not necessary normally because the
disc drive controllers used in "compatibles" employ a different
principle when formatting blank diskettes.

This memory value is saved in a control register and may be
accessed via the MEM_SIZE software interrupt (INT 12h) which
returns the number of Kbytes of RAM in AX. This figure returned
will not, however. be the total RAM but the modified value as
described above. This may be easily seen by booting the sytem, at
which point the free memory found is displayed in the sign-on
message. and then executing the CHKDSK function which will show a
figure approximately 8k bytes smaller.

For those programmers who are interested in knowing obscure
things about the system, the segment used by C-ROM Bios for data
operations (is the value to which the DS segment register is set
to) is stored as the first word of the 4 byte software interrupt
0D0H (address 4 * 0D0H = 360H).   If this value is altered any
access to C-ROM Bios will crash horribly, so be warned!

This value may be used to determine the amount of memory in
the system. but the INT 12H function is to be preferred!

6.2 The Input/Output (IO) Map

The IO map is as below:

Address	Function
00H	Real Time Clock Chip (HM 48818)
01H	
02H	
03H	System Control Port (Write)
03H	System Data Port (Read)
04H	
07FH	On Board UART (INS8250)
08H	
0FFH	Not used
0FFFH	
0FCCH	
0FFFFH	Maps to 80-BUS IO

The on-board IO is mapped in 6 byte steps. Only the RTC chip is decoded, the system control port is a single 8-bit port, the bit setting of the BUSREQ line will ... port. On outputting bit 0 as a 1 will ... BUSREQ, on outputting bit 0 as a 1 the Z80 processor (if present).

Any user program running in the CM256 may then execute as ... addresses an 80-BUS access. Setting Port 400 ... release the Z-80 processor.

The on-board UART is a National Semiconductor INS 8250.

The on-board Real Time Clock chip is a Hitachi HM 48818.

For detailed technical information for these devices should be obtained ...

It is accessible as the top 256 IO ports in the ... to address these ports the equivalent 80-BUS IO port should be decoded added to it (remember the 8088 can be accessed from 00 to ... (remember the 8088 can ... ports).

The address of the CM816 UART is 0B8H when accessed by the CM816 but becomes 0FFB8H when accessed by the CA856.

6.3 On-board Interrupts

It is possible for the CA816/866 to respond to interrupts from either the card or the RTC chip. A simple interrupt structure is provided which uses an 8524H as a very simple controller...

vector	RTC	UART
20H	Yes	No
21H	Yes	No
22H	No	Yes
23H	No	Yes

6.4   Software Interrupts supported by C-ROM Bios

The following software interrupts are supported by the C-ROM Bios V1.1.

"Compatible"

Vector	Function
10H	Video Services
11H	Equipment Interrupt
12H	Memory Size
13H	Disc Interface (floppy and hard disc)
14H	Serial Port
16H	Keyboard
17H	Printer
19H	System Boot

Note that currently the two unsupported interrupts are the "Print Screen" function and the 'Time of Day' interrupt.

6.4.1   Parallel Printer

The Printer function (INT 16H) uses the parallel port on the GM813 (if this is fitted). The Interface is Gemini compatible Centronics.

6.4.2   Serial Interface

Up to 8 serial ports may be provided. At initialisation the C-ROM Bios looks for two ports. one at C80H (the on-board port) and one at 0FFB8H (the GM813 UART). If either of these is found an entry in a control table is marked accordingly. This control table is held in RAM. and if it is wished to access any other INS8250 UARTS via MS-DOS "COMMn:" function, it is possible to modify the table to introduce the device to the C-ROM Bios. Please contact your distributor if you wish to do this.

The on-board INS8250 is COMM1: and the GM813 port is COMM2: if an MS-DOS operating system is used.

6.4.3   Version Number

If a feature of the C-ROM Bios is intended to be factory rated into an application program, then the version number of the C-ROM Bios should be checked. This is held as a packed BCD value at the absolute address 0FE00:0. For version 1.1 this is expressed as "11H". (Version 1.0 didn't have this feature.)

Appendix A - Bibliography

For systems programmers who wish to investigate the features of the operating system more closely the following books are recommended.

1.   The Programmers Guide to the IBM PC

        Peter Norton
        Microsoft Press ISBN 0-14-087-144-6

2.   Programmers Guide to MS-DOS

        Jump
        Brady Communications ISBN 0-8359-3653-5

3.   IBM Personal Computer Disk Operating System Technical
        Reference by Microsoft Corp.

Appendix B - A Mode Change Program

It may be more convenient for the user to have a simple CP/M 80 program to allow the 8086 to run where the system is in "Mode A".

This program must prompt the operator to insert an appropriate MS-DOS or CP/M-86 systems disc in drive A. Then it must issue the appropriate port command (this assumes that link "J" on the CA 856 is connected to the AUX pin on the CA 886).

Where the system has a hard disc it is not necessary to insert a systems disc as C-ROM-Bios ver 1.1 and greater will automatically boot off a hard disc if this is available.

```
                ORG   100H
        bdos    equ     0005H      ; System entry point


        mvi     c, 9              ; Print message requesting
        lxi     d, sys$msg        ; systems disc
        call    bdos

        mvi     c, 1              ; Await any key
        call    bdos

        mvi     a, 0
        out     0BCH              ; Output byte

        mvi     c, 0
        call    bdos              ; Shouldn't be necessary

sys$msg:        db      0dh, 0ah, ' Please insert CA 886 system disc'
                db      ' and press any key$'

        end
```

Appendix C - Disc Drive Controls

There are two aspects of the floppy disc interface which may be controlled by software. These are:

a. The setting of the single/double step flag

b. The setting of the 3 millisecond/6 millisecond step flag.

The actual flag settings apply to all system floppy drives simultaneously. This is because they are intended to be used by any block device driver which is written for multiple configurations of floppy. In practical terms this is almost essential as it is almost impossible to access any other size of drive other than the standard 40 track IBM drive without first providing a suitable block device driver to tell the operating system the various drive parameters.

The disc drive controls are accessed via software interrupts. For a full understanding of what a software interrupt is it is necessary to read the appropriate Intel technical documentation. A software interrupt on an 8088/8086 behaves very much like an RST instruction on the Z-80. allowing access to code in a specified place with a call from anywhere in the memory map.

There are two disc drive control interrupts:

GET$CONTROLS - Interrupt 0D1H.

This returns the current setting of the controls:-

    AH = TRUE means that double stepping is selected.
         FALSE means that single stepping is selected.

    AL = TRUE means that 3 millisecond stepping will occur.
         FALSE means that 6 millisecond stepping will occur.

    SET$CONTROLS - Interrupt 0D2H.

This will configure the controls as required. The controls are set into the AH register as defined above. and then the interrupt is invoked.

e.g. To set the floppy disc interface to single stepping but not affect the step rate control.

                <previous>   : AX will be modified
                INT 0D1H   : Get current setting of controls to AX
                MOV AH. 0   : Clear control to single stepping
                INT 0D2H   : Set current value of AX into controls
                <continue>